Agricultural and Food Scientists

(O*NET 24305A, 24305B, 24305C, and 24305D)

Significant Points

- A large proportion, about 40 percent, of salaried agricultural and food scientists works for Federal, State, and local governments.
- A bachelor's degree in agricultural science is sufficient for some jobs in applied research; a master's or doctoral degree is required for basic research.
- Those with advanced degrees have the best prospects; however, competition may be keen for some basic research jobs if Federal and State funding for these positions is cut.

Nature of the Work

The work of agricultural and food scientists plays an important part in maintaining the Nation's food supply through ensuring agricultural productivity and the safety of the food supply. Agricultural scientists study farm crops and animals and develop ways of improving their quantity and quality. They look for ways to improve crop yield and quality with less labor, control pests and weeds more safely and effectively, and conserve soil and water. They research methods of converting raw agricultural commodities into attractive and healthy food products for consumers.

Agricultural science is closely related to biological science, and agricultural scientists use the principles of biology, chemistry, physics, mathematics, and other sciences to solve problems in agriculture. They often work with biological scientists on basic biological research and in applying to agriculture the advances in knowledge brought about by biotechnology.

Many agricultural scientists work in basic or applied research and development. Others manage or administer research and development programs or manage marketing or production operations in companies that produce food products or agricultural chemicals, supplies, and machinery. Some agricultural scientists are consultants to business firms, private clients, or to government.

Depending on the agricultural or food scientist's area of specialization, the nature of the work performed varies.

Food science. Food scientists and technologists usually work in the food processing industry, universities, or the Federal Government, and help meet consumer demand for food products that are healthful, safe, palatable, and convenient. To do this, they use their knowledge of chemistry, microbiology, and other sciences to develop new or better ways of preserving, processing, packaging, storing, and delivering foods. Some food scientists engage in basic research, discovering new food sources; analyzing food content to determine levels of vitamins, fat, sugar, or protein; or searching for substitutes for harmful or undesirable additives, such as nitrites. They also develop ways to process, preserve, package, or store food according to industry and government regulations. Others enforce government regulations, inspecting food processing areas and ensuring that sanitation, safety, quality, and waste management standards are met. Food technologists generally work in product development, applying the findings from food science research to the selection, preservation, processing, packaging, distribution, and use of safe, nutritious, and wholesome food.

Plant science. Agronomy, crop science, entomology, and plant breeding are included in plant science. Scientists in these disciplines study plants and their growth in soils, helping producers of food, feed, and fiber crops to continue to feed a growing population while conserving natural resources and maintaining the environment. Agronomists and crop scientists not only help increase productivity, but also study ways to improve the nutritional value of crops and the quality of seed. Some crop scientists study the breeding, physiology, and management of crops and use genetic engineering to develop crops resistant to pests and drought. Entomologists conduct research to develop new technologies to control or eliminate pests in infested areas and prevent the spread of harmful pests to new areas, as well as technologies that are compatible with the environment. They also conduct research or engage in oversight activities aimed at halting the spread of insect-borne disease.

Soil science. Soil scientists study the chemical, physical, biological, and mineralogical composition of soils as they relate to plant or crop growth. They also study the responses of various soil types to fertilizers, tillage practices, and crop rotation. Many soil scientists who work for the Federal Government conduct soil surveys, classifying and mapping soils. They provide information and recommendations to farmers and other landowners regarding the best use of land and plant growth, and how to avoid or correct problems such as erosion. They may also consult with engineers and other technical personnel working on construction projects about the effects of, and solutions to, soil problems. Since soil science is closely related to environmental science, persons trained in soil science also apply their knowledge to ensure environmental quality and effective land use.

Animal science. Animal scientists work to develop better, more efficient ways of producing and processing meat, poultry, eggs, and milk. Dairy scientists, poultry scientists, animal breeders, and other related scientists study the genetics, nutrition, reproduction, growth, and development of domestic farm animals. Some animal scientists inspect and grade livestock food products, purchase livestock, or work in technical sales or marketing. As extension agents or consultants, animal scientists advise agricultural producers on how to upgrade animal housing facilities properly, lower mortality rates, handle waste matter, or increase production of animal products, such as milk or eggs.

Agricultural scientists gather data and inpsect results of their work in the field.

Working Conditions
Agricultural scientists involved in management or basic research tend to work regular hours in offices and laboratories. The working environment for those engaged in applied research or product development varies, depending on the discipline of agricultural science and the type of employer. For example, food scientists in private industry may work in test kitchens while investigating new processing techniques. Animal scientists working for Federal, State, or university research stations may spend part of their time at dairies, farrowing houses, feedlots, farm animal facilities, or outdoors conducting research associated with livestock. Soil and crop scientists also spend time outdoors conducting research on farms and agricultural research stations. Entomologists work in laboratories, insectories, or agricultural research stations, and may also spend time outdoors studying or collecting insects in their natural habitat.

Employment
Agricultural scientists held about 21,000 jobs in 1998. In addition, several thousand persons held agricultural science faculty positions in colleges and universities. (See the statement on college and university faculty elsewhere in the *Handbook*.)

About 40 percent of all nonfaculty salaried agricultural and food scientists work for Federal, State, or local governments. Nearly 1 out of 4 worked for the Federal Government in 1998, mostly in the Department of Agriculture. In addition, large numbers worked for State governments at State agricultural colleges or agricultural research stations. Some worked for agricultural service companies; others worked for commercial research and development laboratories, seed companies, pharmaceutical companies, wholesale distributors, and food products companies. About 3,700 agricultural scientists were self-employed in 1998, mainly as consultants.

Training, Other Qualifications, and Advancement
Training requirements for agricultural scientists depend on their specialty and on the type of work they perform. A bachelor's degree in agricultural science is sufficient for working some jobs in applied research or for assisting in basic research, but a master's or doctoral degree is required for basic research. A Ph.D. in agricultural science is usually needed for college teaching and for advancement to administrative research positions. Degrees in related sciences such as biology, chemistry, or physics or in related engineering specialties also may qualify persons for some agricultural science jobs.

All States have a land-grant college that offers agricultural science degrees. Many other colleges and universities also offer agricultural science degrees or some agricultural science courses. However, not every school offers all specialties. A typical undergraduate agricultural science curriculum includes communications, economics, business, and physical and life sciences courses, in addition to a wide variety of technical agricultural science courses. For prospective animal scientists, these technical agricultural science courses might include animal breeding, reproductive physiology, nutrition, and meats and muscle biology.

Students preparing as food scientists take courses such as food chemistry, food analysis, food microbiology, and food processing operations. Those preparing as crop or soil scientists take courses in plant pathology, soil chemistry, entomology, plant physiology, and biochemistry, among others. Advanced degree programs include classroom and fieldwork, laboratory research, and a thesis or dissertation based on independent research.

Agricultural and food scientists should be able to work independently or as part of a team and be able to communicate clearly and concisely, both in speaking and in writing. Most agricultural scientists also need an understanding of basic business principles.

The American Society of Agronomy offers certification programs in crops, agronomy, crop advising, soils, horticulture, plant pathology, and weed science. To become certified, applicants must meet certain standards for examination, education, and professional work experience.

Agricultural scientists who have advanced degrees usually begin in research or teaching. With experience, they may advance to jobs such as supervisors of research programs or managers of other agriculture-related activities.

Job Outlook
Employment of agricultural scientists is expected to grow about as fast as the average for all occupations through 2008. Additionally, the need to replace agricultural and food scientists who retire or otherwise leave the occupation permanently will account for many more job openings than projected growth.

Past agricultural research has resulted in the development of higher-yielding crops, crops with better resistance to pests and plant pathogens, and chemically-based fertilizers and pesticides. Further research is necessary as insects and diseases continue to adapt to pesticides, and as soil fertility and water quality deteriorate. Agricultural scientists are using new avenues of research in biotechnology to develop plants and food crops that require less fertilizer, fewer pesticides and herbicides, and even less rain.

Agricultural scientists will be needed to balance increased agricultural output with protection and preservation of soil, water, and ecosystems. They will increasingly encourage the practice "sustainable agriculture" by developing and implementing plans to manage pests, crops, soil fertility and erosion, and animal waste in ways that reduce the use of harmful chemicals and do little damage to the natural environment. Also, an expanding population and an increasing public focus on diet, health, and food safety, will result in job opportunities for food scientists and technologists.

Graduates with advanced degrees will be in the best position to enter jobs as agricultural scientists. However, competition may be keen for teaching positions in colleges or universities and for some basic research jobs, even for doctoral holders. Federal and State budget cuts may limit funding for these positions through 2008.

Bachelor's degree holders can work in some applied research and product development positions, but usually only in certain subfields, such as food science and technology. Also, the Federal Government hires bachelor's degree holders to work as soil scientists. Despite the more limited opportunities for those with only a bachelor's degree to obtain jobs as agricultural scientists, a bachelor's degree in agricultural science is useful for managerial jobs in businesses that deal with ranchers and farmers, such as feed, fertilizer, seed, and farm equipment manufacturers; retailers or wholesalers; and farm credit institutions. Four-year degrees may also help persons enter occupations such as farmer or farm or ranch manager, cooperative extension service agent, agricultural products inspector, or purchasing or sales agent for agricultural commodity or farm supply companies.

Earnings
Median annual earnings of agricultural and food scientists were $42,340 in 1998. The middle 50 percent earned between $32,370 and $59,240. The lowest 10 percent earned less than $24,200 and the highest 10 percent earned more than $79,820.

Average Federal salaries for employees in nonsupervisory, supervisory, and managerial positions in certain agricultural science specialties in 1999 were as follows: Animal science, $69,400; agronomy, $57,200; soil science, $53,600; horticulture, $53,800; and entomology, $65,600.

According to the National Association of Colleges and Employers, beginning salary offers in 1999 for graduates with a bachelor's degree in animal science averaged about $27,600 a year.

Related Occupations
The work of agricultural scientists is closely related to that of biologists and other natural scientists such as chemists, foresters, and

conservation scientists. It is also related to agricultural production occupations such as farmer and farm manager and cooperative extension service agent. Certain specialties of agricultural science are also related to other occupations. For example, the work of animal scientists is related to that of veterinarians; horticulturists, to landscape architects; and soil scientists, to soil conservationists.

Sources of Additional Information

Information on careers in agricultural science is available from:

☛ American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, 677 S. Segoe Rd., Madison, WI 53711-1086.

☛ Food and Agricultural Careers for Tomorrow, Purdue University, 1140 Agricultural Administration Bldg., West Lafayette, IN 47907-1140.

For information on careers in food technology, write to:

☛ Institute of Food Technologists, Suite 300, 221 N. LaSalle St., Chicago IL 60601-1291.

For information on education in food safety, contact:

☛ National Alliance for Food Safety, Office of the Secretariat, 205 Agriculture Building, University of Arkansas, Fayetteville, AR 72701.

For information on careers in entomology, contact:

☛ Entomological Society of America, 9301 Annapolis Rd., Lanham, MD 20706, Attn: Public Relations Coordinator.

Information on acquiring a job as an agricultural scientist with the Federal Government may be obtained from the Office of Personnel Management through a telephone-based system. Consult your telephone directory under U.S. Government for a local number, or call (912) 757-3000 (TDD 912-744-2299). That number is not toll-free and charges may result. Information also is available from their Internet site: **http://www.usajobs.opm.gov**

Biological and Medical Scientists

(O*NET 24308A, 24308B, 24308C, 24308D, 24308E, 24308F, 24308G, 24308H, 24308J, and 24311)

Significant Points

- Biological scientists usually require a Ph.D. degree for independent research but a master's degree is sufficient for some jobs in applied research or product development; a bachelor's degree is adequate for some non-research jobs.
- Medical scientist jobs require a Ph.D. degree in a biological science, but some jobs need a medical degree.
- Doctoral degree holders face considerable competition for independent research positions; holders of bachelor's or master's degrees in biological science can expect better opportunities in non-research positions.

Nature of the Work

Biological and medical scientists study living organisms and their relationship to their environment. Most specialize in some area of biology such as zoology (the study of animals) or microbiology (the study of microscopic organisms).

Many biological scientists and virtually all medical scientists work in research and development. Some conduct basic research to advance knowledge of living organisms, including viruses, bacteria, and other infectious agents. Past research has resulted in the development of vaccines, medicines, and treatments for cancer and other diseases. Basic biological and medical research continues to provide the building blocks necessary to develop solutions to human health problems and to preserve and repair the natural environment. Many biological and medical scientists work independently in private industry, university, or government laboratories, often exploring new areas of research or expanding on specialized research started in graduate school. Those who are not wage and salary workers in private industry typically submit grant proposals to obtain funding for their projects. Colleges and universities, private industry, and Federal Government agencies, such as the National Institutes of Health and the National Science Foundation, contribute to the support of scientists whose research proposals are determined to be financially feasible and have the potential to advance new ideas or processes.

Biological and medical scientists who work in applied research or product development use knowledge provided by basic research to develop new drugs and medical treatments, increase crop yields, and protect and clean up the environment. They usually have less autonomy than basic researchers to choose the emphasis of their research, relying instead on market-driven directions based on the firm's products and goals. Biological and medical scientists doing applied research and product development in private industry may be required to express their research plans or results to nonscientists who are in a position to veto or approve their ideas, and they must understand the business impact of their work. Scientists are increasingly working as part of teams, interacting with engineers, scientists of other disciplines, business managers, and technicians. Some biological and medical scientists also work with customers or suppliers, and manage budgets.

Biological and medical scientists who conduct research usually work in laboratories and use electron microscopes, computers, thermal cyclers, or a wide variety of other equipment. Some conduct experiments using laboratory animals or greenhouse plants. For some biological scientists, a good deal of research is performed outside of laboratories. For example, a botanist may do research in tropical rain forests to see what plants grow there, or an ecologist may study how a forest area recovers after a fire.

Some biological and medical scientists work in managerial or administrative positions, usually after spending some time doing research and learning about the firm, agency, or project. They may plan and administer programs for testing foods and drugs, for example, or direct activities at zoos or botanical gardens. Some biological scientists work as consultants to business firms or to government, while others test and inspect foods, drugs, and other products.

In the 1980s, swift advances in basic biological knowledge related to genetics and molecules spurred growth in the field of biotechnology. Biological and medical scientists using this technology manipulate the genetic material of animals or plants, attempting to make organisms more productive or resistant to disease. Research using biotechnology techniques, such as recombining DNA, has led to the discovery of important drugs, including human insulin and growth hormone. Many other substances not previously available in large quantities are starting to be produced by biotechnological means; some may be useful in treating cancer and other diseases. Today, many biological and medical scientists are involved in biotechnology, including those who work on the Human Genome project, isolating, identifying, and sequencing human genes. This work continues to lead to the discovery of the genes associated with specific diseases and inherited traits, such as certain types of cancer or obesity. These advances in biotechnology have opened up research opportunities in almost all areas of biology, including commercial applications in agriculture, environmental remediation, and the food and chemical industries.

Most biological scientists who come under the category of *biologist* are further classified by the type of organism they study or by the specific activity they perform, although recent advances in the understanding of basic life processes at the molecular and cellular levels have blurred some traditional classifications.

Aquatic biologists study plants and animals living in water. *Marine biologists* study salt water organisms and *limnologists* study fresh water organisms. Marine biologists are sometimes mistakenly called oceanographers, but oceanography is the study of the